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Radio Signaling System for the New York Police Department

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SYNOPSIS: By means of the radio signaling system described it is possible, through the addition of a comparatively simple attachment to a standard radio telephone transmitter, to modulate the carrier with an audio frequency tone in such a manner as to provide for calling individually, simultaneously, or in a number of designated groups, any one of several hundred radio receiving stations. At the radio receiving stations apparatus is provided which may be operated from commercial sources of power supply and by means of which a visible or audible signal is given to the operator that a message is about to be broadcast, to which he should listen. Signals are also provided which, in case of improper operation, immediately inform the operator of the points at which attention is required.

INTRODUCTION

FOR some time the New York Police Department has been employing the municipal broadcasting station WNYC to broadcast descriptions of missing persons and other features of police work in which it is desired to enlist the cooperation of the public. The success of this program has been such that the Police Department wished to equip the precinct houses and police booths located in various parts of the city with receiving sets with which they could listen in on communications from the headquarters station WNYC. The fundamental requirement was signaling apparatus incorporated in the receiving sets which would attract the attention of the attendant at the proper times. The system which was finally developed by the engineers of the Bell Telephone Laboratories, Inc., in cooperation with the New York Police Department is an excellent illustration of the adaptability of wire practices to the radio field. The underlying principles employed and much of the apparatus used had previously found extensive application in the Bell System and elsewhere.

The basis of this system is the Western Electric telephone train dispatching system which is in rather general use on railroads throughout the world for the purpose of providing selective signaling on their train dispatching telephone systems. For every division, these systems consist ordinarily of a single line to which are connected a number of stations capable of being called by the dispatcher in-

dividually, simultaneously or in groups.[1] This signaling system has also been adapted to radio transmission.[2] Its use permits broadcasting from a central radio transmitting station to police organization districts, patrol boats and automobiles without requiring the constant attention of operators at the receiving stations.

Requirements of the System

Before describing the system which was finally worked out to meet the requirements of the New York Police Department, it seems best to state the nature of these requirements. For a system employed to handle communications ranging all the way from routine messages between police headquarters and its different outlying police stations and patrols to general alarms for insuring the capture of escaping criminals, absolute reliability and flexibility are of the utmost importance. The central station must be able to call the receiving stations individually, collectively, or in a number of designated group combinations corresponding to the police organization districts. To accomplish this result effectively, means must be provided whereby the desired signal may be sent automatically by a simple manual operation. The apparatus for this purpose must be in the form of an attachment which may be used with a standard radio telephone transmitter without extensive modifications.

As the receiver will be in operation continuously, the difficult and expensive maintenance of batteries must be avoided by energizing the vacuum tubes from the commercial power supply system. The tuning arrangements of the receiver must be of the simplest possible character and must be capable of being locked to insure that the receiver remains tuned to the transmitting frequency. The selectivity and sensitivity must be sufficient to insure reliable operation under all conditions. The receiver must provide means for listening to all material broadcast by the central broadcasting station but the signaling system should respond only to signals from the transmitter signaling attachment, irrespective of broadcast speech, music and telegraph signals which may involve the same frequencies. Visible indications should be provided to show when the receiver is in operating condition. The receiver should respond to a call from the central station by operating another visible indicator, in addition to a bell or other audible signal, if desired.

[1] "Modern Methods in Train Dispatching," by J. C. Latham, *Electrical Communication*, Vol. III, No. 1, July, 1924.

[2] "Radio Telephone Signaling Low-Frequency System," by C. S. Demarest, M. L. Almquist and L. M. Clement, *Journal of the A. I. E. E.*, Vol. XLIII, No. 3 March, 1924.

Description of Apparatus

Transmitter Attachment

A photograph of the transmitter attachment is shown in Fig. 1, and a schematic circuit is given in Fig. 2. The apparatus consists of a vacuum tube oscillator and a number of calling keys. These

Fig.1—Transmitter attachment

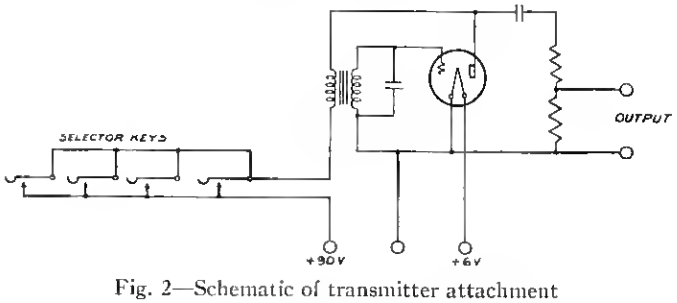

Fig. 2—Schematic of transmitter attachment

keys, which are connected in parallel, are in series with the plate winding of the oscillator coil. Operating any one of the calling keys opens and closes its contacts in a regular sequence determined by the code for which the key is set. Five group keys and a master key are

provided. Each of the group keys is set to a certain code call which may be changed by resetting the key by means of a screw-driver. One of these group keys may be used as a call for the entire system so that by the operation of this key, every receiver is called simultaneously. The other keys may be used for the four main group calls. The master key is similar in appearance to a miniature cash register and by setting its levers to the proper code combination, any desired station may be called individually and this key may also be used for the sub-group combinations.

The output terminals of the oscillator of the transmitter attachment may be connected directly to the speech input equipment of a standard radio telephone transmitter in place of the microphone. The speech input amplifier is adjusted so that when the signaling attachment is used the maximum possible modulation is obtained. The sensitivity of the radio receiver is adjusted for reliable operation of the signaling system, which is sharply tuned to the frequency of the transmitter attachment. This frequency is 3,000 cycles and is so high that the volume of music or speech will be amply sufficient for easy reception but yet insufficient to operate the signaling system relays as only a relatively small proportion of the energy in normal speech or music occurs at frequencies in the vicinity of 3,000 cycles. Even should the relays be operated occasionally by excessive volume of speech or music the receiver signal lamp will not light unless the proper code call is sent.

Receiving Apparatus

Photographs of the receiving equipment are shown in Figs. 3, 4 and 5. At some of the outlying stations of the New York Police Department 110-volt DC power supply is available while at others 110 volt 60 cycle AC is provided. The radio receivers are made in two different types, one type for each kind of power supply. A schematic circuit of the DC type of receiver is shown in Fig. 6 and that of the AC type in Fig. 7. These two types are similar in all respects except such modifications as the different sources of power supply necessitate.

In the direct current type of receiver all of the vacuum tube filaments are connected in series, current being taken directly from the line through a filter to eliminate line noises due to generator hum and other causes. In parallel with each filament is connected a small switchboard lamp with a red cap mounted on the panel of the receiver cabinet. The resistance of each lamp filament is sufficiently greater than that of the vacuum tube filament so that the lamp will light

only when the vacuum tube filament burns out or the tube is removed from its socket. In order to indicate when the power is turned on the receiver there is another lamp (green) mounted on the panel and connected across the 110 volt direct current line on the receiver side of the main switch so that when the switch is closed the lamp will light.

In the alternating current type of receiver the filaments of the

Fig. 3—Exterior view of receiving set. (The external appearance of the A.C. and D.C. models is the same)

Fig. 4—View of A.C. model receiver showing tuning controls, and selector, and rectifying apparatus

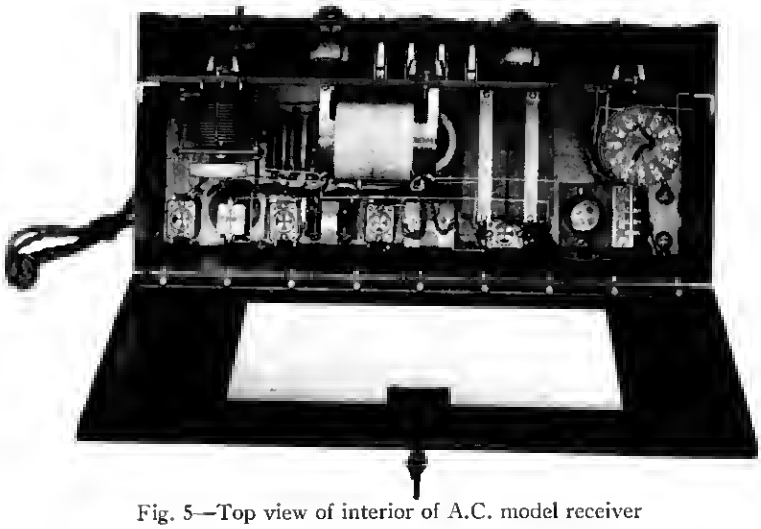

Fig. 5—Top view of interior of A.C. model receiver

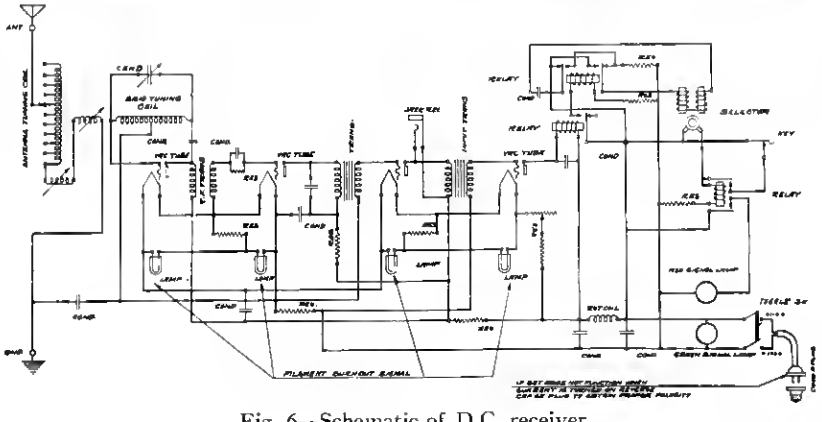

Fig. 6—Schematic of D.C. receiver

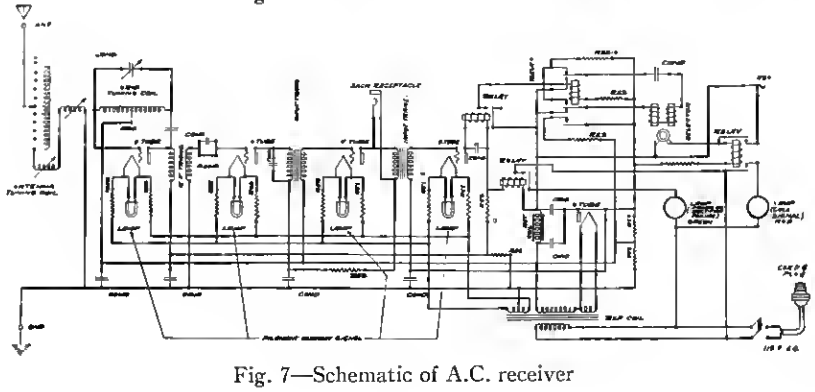

Fig. 7—Schematic of A.C. receiver

vacuum tubes are connected in parallel and are operated on alternating current. In order to take care of the filament warning lamps a resistance is provided in series with each tube filament so that when this filament burns out the voltage will rise sufficiently to light the corresponding lamp. To supply the necessary direct current for the plate potential of the vacuum tubes and for the operation of the relays, this receiver is provided with a power rectifier tube. The rectifier tube circuit is connected to the high voltage secondary winding of a power transformer and in connection with a filter system supplies to the receiver 110 volts direct current. As an indication of a burnt out rectifier tube filament there is provided a relay connected in series with the rectified current and a green signal lamp connected across the line in series with the contacts of this relay. The lamp will light when the power is turned on only if the rectifier tube is functioning properly. Thus it serves two useful purposes.

Both the DC and AC types of radio receivers are designed for operation from an open antenna, a double tuned, inductively coupled circuit being employed. The antenna circuit is tuned by means of taps on the loading coil and a small series inductance whose coupling to the loading coil is variable. An adjustable coupling coil is also included in the antenna circuit and serves as a sensitivity control. The secondary circuit to which this coil is coupled is tuned by means of a variable air condenser. All of these controls are on a panel inside the receiver and are inaccessible when the receiver cabinet is locked, thus insuring their remaining in adjustment.

Four "peanut" vacuum tubes are employed in the radio receiver. The first tube serves as a radio frequency amplifier. By means of a fixed radio frequency transformer sharply tuned to the frequency of the transmitting station, this tube is coupled to the second tube, which acts as a grid leak detector. This arrangement provides additional selectivity and more amplification than if a broadly tuned transformer were used, and is permissible since, in any given system, it is anticipated that the transmitter frequency will remain constant. To adapt the receiver to operate at any other transmitting frequency the transformers may be readily replaced by others of the proper characteristics. The third tube serves as an audio-frequency amplifier, being coupled to the detector tube by means of an audio-frequency transformer having a frequency characteristic suitable for the transmission of speech or music. The fourth tube serves as a rectifier and is coupled to the amplifier by means of a transformer, sharply tuned to the signaling frequency of 3,000 cycles. This frequency, as noted above, is sufficiently above the preponderant frequencies

of normal speech or music to make the accidental operation of the signaling system a very remote possibility.

The normal plate current in the rectifier tube is a small fraction of a milliampere. Upon a signal being received, this current increases sufficiently to operate a relay connected in the plate circuit. The operation of this relay closes a circuit through the winding of another relay, which is the reversing relay for the operation of the selector controlling the red signal lamp which indicates a call.

The selector is the heart of the signaling system. This selector is shown in Fig. 8. It consists of a mechanism unit mounted upon a magnet unit, the whole being enclosed in a glass case for protection.

Fig. 8—Selector

The magnet windings are connected to a source of direct current of suitable voltage in series with a large fixed condenser and the contacts of the reversing relay mentioned above. When this relay is in either end position the circuit is completed through the condenser and the windings of the selector. As the power source is direct current it serves only to charge the condenser to its own potential. When the reversing relay is alternately operated and released, however, the repeated charging of this condenser in opposite directions sends pulses of current through the windings of the selector. This gives a rocking motion to the armature of the selector which motion is transmitted through a ratchet to the selector code wheel, advancing it against the tension of a spring one step for each movement of the armature. If the code wheel is kept from flying back during the pauses, two in number, which occur between groups of impulses, as is the case when the signal

corresponds to the code setting of a particular selector, it will be advanced step by step until it reaches the point at which it makes signaling contact. For any other signal, however, it will be released at the pause between some two groups of pulses and will then immediately fly back to its initial position. To hold the code wheel during signal pauses a series of pins is arranged to engage a spring arm on the selector frame, their position thus determining the code of the particular selector. As the master key can be so operated as to send signals without any pause a general call can be made through all selectors simultaneously whatever their code setting. When the code wheel has rotated a distance corresponding to twenty-seven impulses, a spring contact mounted upon it makes contact with the first of a series of four stationary contacts A, B, C, and D. Two more impulses make contact with the second of the series, two more with the third, and two more, or a total of 33, with the fourth. Only one of these contacts is connected in any individual selector and four large groups are thus provided. All the transmitting keys are so arranged that about one second after the completion of their calling signal, they send a signal which restores all selectors under their control to normal.

By omitting one or both of the pauses between the three groups of impulses, it is apparent that each selector will respond to four and only four systems of pulses for each contact. On contact A, for example, the selector will close the signaling circuit if its individual call is sent, if the first pause only or the second pause only is omitted, or if both pauses are omitted and 27 consecutive impulses are sent. All of the selectors using any one of the four contacts may thus be grouped in several different ways. The total possible number of individual stations in each of the four large groups is somewhat over 200, or over 800 in the entire system, the exact number depending upon the grouping system which is employed. Each large group may be subdivided into a number of small groups having from 15 to 20 stations in each group, of which each station may belong to two groups if desired. In any case the number of consecutive impulses without pauses corresponding to the contact used will call all the stations in that large group, the sub-groups being formed by omitting one of the pauses. The system is thus capable of a high degree of flexibility.

The operation of the selector closes a circuit through the winding of a relay. This relay is of the slow operating type, this being necessary in order to avoid signals due to momentary contacts which are made by the selector with certain code combinations. The relay is

provided with a holding contact so that after the selector has been restored to normal by the releasing impulse, it will remain operated until the person at the receiving station presses the key which opens the circuit of the holding contact. In the operated position, the relay completes the circuit of the red signal lamp on the panel of the receiver, thus indicating to the operator that he has been called. An audible signal may also be connected in parallel with it, using an additional relay if necessary to handle the heavy current required by a large gong.

In the exterior views of the receivers at the extreme left of the receiver is shown a jack into which the head telephones may be plugged. Plugging in these telephones does not interfere in any way with the operation of the signal system. Just to the right of the telephone jack is shown the red signal lamp for indicating when the receiver has been called. In the middle of the panel is a key which is used by the operator of the receiver to extinguish the red signal lamp when he takes up his head telephones. To the right of the key is the green signal lamp indicating when the power is on the receiver, and to the extreme right is the switch for turning the power on and off.